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- 1 [Topology matching for fully automatic similarity estimation of 3D shapes](#)
Masaki Hliaga, Yoshinisa Shinagawa, Taku Kohnmura, Toshiyasu L. Kunii
August 2001 [Proceedings of the 28th annual conference on Computer graphics and interactive techniques](#)
Publisher: ACM Press

Full text available: [pdf\(463.27 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

There is a growing need to be able to accurately and efficiently search visual data sets, and in particular, 3D shape data sets. This paper proposes a novel technique, called *Topology Matching*, in which similarity between polyhedral models is quickly, accurately, and automatically calculated by comparing Multiresolutional Reeb Graphs (MRGs). The MRG thus operates well as a search key for 3D shape data sets. In particular, the MRG represents the skeletal and topological structure of a 3 ...

Keywords: 3D search, computer vision, shape recognition

- 2 [Shape-based retrieval and analysis of 3D models](#)

Thomas Funkhouser, Michael Kazhdan
August 2004 [Proceedings of the conference on SIGGRAPH 2004 course notes SIGGRAPH '04](#)

Publisher: ACM Press
Full text available: [pdf\(12.56 MB\)](#) Additional Information: [full citation](#), [abstract](#)

Large repositories of 3D data are rapidly becoming available in several fields, including mechanical CAD, molecular biology, and computer graphics. As the number of 3D models grows, there is an increasing need for computer algorithms to help people find the interesting ones and discover relationships between them. Unfortunately, traditional text-based search techniques are not always effective for 3D models, especially when queries are geometric in nature (e.g., find me objects that fit into thi ...

- 3 [Feature-based similarity search in 3D object databases](#)

Benjamin Bustos, Daniel A. Keim, Dietmar Saupe, Tobias Schreck, Dejan V. Vranic
December 2005 [ACM Computing Surveys \(CSUR\)](#), Volume 37 Issue 4

Publisher: ACM Press
Full text available: [pdf\(5.28 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

The development of effective content-based multimedia search systems is an important research issue due to the growing amount of digital audio-visual information. In the case of images and video, the growth of digital data has been observed since the introduction of 2D capture devices. A similar development is expected for 3D data as acquisition and dissemination technology of 3D models is constantly improving. 3D objects are becoming

an important type of multimedia data with many promising appl ...

Keywords: 3D model retrieval, content-based similarity search

- 4 [Image retrieval: Retrieving 3D shapes based on their appearance](#)
Ryutarou Ohbuchi, Masatoshi Nakazawa, Tsuyoshi Takei
November 2003 [Proceedings of the 5th ACM SIGMM International workshop on Multimedia Information retrieval](#)
Publisher: ACM Press

Full text available: [pdf\(559.68 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

In this paper, we propose an algorithm for shape-similarity comparison and retrieval of 3D shapes defined as polygon soup. One of the issues in comparing 3D shapes is the diversity of shape representations used to represent these "3D" shapes. While a solid model is well-defined and is easier to handle, others such as polygon soup poses many problems. In fact, a polygon soup 3D model most often does not define a 3D shape, but merely an illusion of "3D shape-ness" by its collection of independent ...

Keywords: depth map, geometric modeling, polygon soup, polygonal mesh, shape similarity search, three-dimensional models

- 5 [Salient geometric features for partial shape matching and similarity](#)

Ran Gal, Daniel Cohen-Or
January 2006 [ACM Transactions on Graphics \(TOG\)](#), Volume 25 Issue 1

Publisher: ACM Press
Full text available: [pdf\(761.63 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

This article introduces a method for partial matching of surfaces represented by triangular meshes. Our method matches surface regions that are numerically and topologically dissimilar, but approximately similar regions. We introduce novel local surface descriptors which efficiently represent the geometry of local regions of the surface. The descriptors are defined independently of the underlying triangulation, and form a compatible representation that allows matching of surfaces with different ...

Keywords: Partial matching, geometric transformations, salient features, shape retrieval, similarity

- 6 [Shape retrieval and watermarking: Scale-space representation of 3D models and topological matching](#)

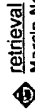
Dmitry Bespalov, Ali Shokoufandeh, William C. Regli, Wei Sun
June 2003 [Proceedings of the eighth ACM symposium on Solid modeling and applications](#)
Publisher: ACM Press

Full text available: [pdf\(668.64 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Reeb graphs have been shown to be effective for topology matching of 3D objects. Their effectiveness breaks down, however, when the individual models become very geometrically and topologically detailed---as is the case for complex machined parts. The result is that Reeb graph techniques, as developed for matching general shape and computer graphics models, produce poor results when directly applied to create engineering databases. This paper presents a framework for shape matching through scale- ...

Keywords: matching, scale-space, solid modelling

- 7 [Shape retrieval and watermarking: 3D zernike descriptors for content based shape](#)



retrieval
Marcin Novotni, Reinhard Klein

June 2003 **Proceedings of the eighth ACM symposium on Solid modeling and applications**

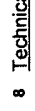
Publisher: ACM Press

Full text available: [pdf\(1.23.MB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Content based 3D shape retrieval for broad domains like the World Wide Web has recently gained considerable attention in Computer Graphics community. One of the main challenges in this context is the mapping of 3D objects into compact canonical representations referred to as descriptors, which serve as search keys during the retrieval process. The descriptors should have certain desirable properties like invariance under scaling, rotation and translation. Very importantly, they should possess de ...

Keywords: 3D Zernike moments, invariants, shape descriptor, shape retrieval



8 Technical session 8: compression, streaming, and retrieval of 3D objects: Interactive retrieval of 3D shape models using physical objects

Hiroyasu Ichida, Yuichi Itoh, Yoshifumi Kitamura, Fumio Kishino

October 2004 **Proceedings of the 12th annual ACM international conference on Multimedia**

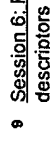
Publisher: ACM Press

Full text available: [pdf\(2.67.MB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

We present a novel method for interactive retrieval of 3D shapes using physical objects. Our method is based on simple physical 3D interaction with a set of tangible blocks. As the user connects blocks, the system automatically recognizes the shape of the constructed physical structure and picks similar 3D shape models from a preset model database, in real time. Our system fully supports interactive retrieval of 3D shape models in an extremely simple fashion, which is completely non-verbal and cross ...

Keywords: 3D shape model, Voxel data, physical object, retrieval system



9 Session 6: Rotation invariant spherical harmonic representation of 3D shape descriptors

Michael Kazhdan, Thomas Funkhouser, Szymon Rusinkiewicz

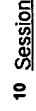
June 2003 **Proceedings of the 2003 Eurographics / ACM SIGGRAPH symposium on Geometry processing SGP '03**

Publisher: Eurographics Association

Full text available: [pdf\(2.63.MB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

One of the challenges in 3D shape matching arises from the fact that in many applications, models should be considered to be the same if they differ by a rotation. Consequently, when comparing two models, a similarity metric implicitly provides the measure of similarity at the optimal alignment. Explicitly solving for the optimal alignment is usually impractical. So, two general methods have been proposed for addressing this issue: (1) Every model is represented using rotation invariant descriptors ...



10 Session 4: Symmetry descriptors and 3D shape matching

Michael Kazhdan, Thomas Funkhouser, Szymon Rusinkiewicz

July 2004 **Proceedings of the 2004 Eurographics / ACM SIGGRAPH symposium on Geometry processing SGP '04**

Publisher: ACM Press

Full text available: [pdf\(336.98.KB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

In this paper, we present the Symmetry Descriptors of a 3D model. This is a collection of spherical functions that describes the measure of a model's rotational and reflective

symmetry with respect to every axis passing through the center of mass. We show that Symmetry Descriptors can be computed efficiently using fast signal processing techniques, and demonstrate the empirical value of Symmetry Descriptors by showing that they improve matching performance in a variety of shape retrieval experiments ...

11 A search engine for 3D models

Thomas Funkhouser, Patrick Min, Michael Kazhdan, Joyce Chen, Alex Halderman, David Dobkin, David Jacobs

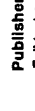
January 2003 **ACM Transactions on Graphics (TOG)**, Volume 22 Issue 1

Publisher: ACM Press

Full text available: [pdf\(7.91.MB\)](#)
Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

As the number of 3D models available on the Web grows, there is an increasing need for a search engine to help people find them. Unfortunately, traditional text-based search techniques are not always effective for 3D data. In this article, we investigate new shape-based search methods. The key challenges are to develop query methods simple enough for novice users and matching algorithms robust enough to work for arbitrary polygonal models. We present a Web-based search engine system that support ...

Keywords: Search engine, shape matching, shape representation, shape retrieval



12 Shape analysis: Shape matching and anisotropy

Michael Kazhdan, Thomas Funkhouser, Szymon Rusinkiewicz

August 2004 **ACM Transactions on Graphics (TOG)**, Volume 23 Issue 3

Publisher: ACM Press

Full text available: [pdf\(344.15.KB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

With recent improvements in methods for the acquisition and rendering of 3D models, the need for retrieval of models has gained prominence in the graphics and vision communities. A variety of methods have been proposed that enable the efficient querying of model repositories for a desired 3D shape. Many of these methods use a 3D model as a query and attempt to retrieve models from the database that have a similar shape. In this paper we consider the implications of anisotropy on the shape matching ...

Keywords: anisotropy, shape matching



13 Shape distributions

Robert Osada, Thomas Funkhouser, Bernard Chazelle, David Dobkin

October 2002 **ACM Transactions on Graphics (TOG)**, Volume 21 Issue 4

Publisher: ACM Press

Full text available: [pdf\(3.46.MB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Measuring the similarity between 3D shapes is a fundamental problem, with applications in computer graphics, computer vision, molecular biology, and a variety of other fields. A challenging aspect of this problem is to find a suitable shape signature that can be constructed and compared quickly, while still discriminating between similar and dissimilar shapes. In this paper, we propose and analyze a method for computing shape signatures for arbitrary (possibly degenerate) 3D polygonal models. The ...

Keywords: Shape analysis, shape representation



14 Image II: Efficient 3D object retrieval using depth images

N. Vajramushti, I. A. Kakadiaris, T. Theoharis, G. Papaloannou

October 2004 **Proceedings of the 6th ACM SIGMM International workshop on**

Multimedia Information retrieval

Publisher: ACM Press

Full text available: [pdf\(230.59 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

In this paper, we present a new three-dimensional object retrieval method. This method employs depth buffers for representing and comparing the objects. Specifically, multiple depth buffers per object (computed from different points of view) are compared for surface and volume similarity. Our method is easily extensible for hierarchical comparisons at multiple resolutions and is highly parallelizable. We have employed this method for both inter-class and intra-class retrieval tasks on a galle ...

Keywords: shape matching, shape representation, shape retrieval

15 [Image I: Retrieval of 3D objects by visual similarity](#)

Jürgen Assfalg, Alberto Del Bimbo, Pietro Pala

October 2004 **Proceedings of the 6th ACM SIGMM International workshop on****Multimedia Information retrieval**

Publisher: ACM Press

Full text available: [pdf\(188.89 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Along with images and videos, 3D models have recently gained increasing attention for a number of reasons: advancements in 3D hardware and software technologies, their ever decreasing prices and increasing availability, affordable 3D authoring tools, and the establishment of open standards for 3D data interchange. The ever increasing availability of 3D models demands for tools supporting their effective and efficient management. Among these tools, those enabling content-based retrieval play a ...

Keywords: 3D models, content-based retrieval, spin images

16 [Efficient geometry-based similarity search of 3D spatial databases](#)

Daniel A. Keim

June 1999 **ACM SIGMOD Record , Proceedings of the 1999 ACM SIGMOD International conference on Management of data SIGMOD '99**, Volume 28 Issue 2

Publisher: ACM Press

Full text available: [pdf\(1.40 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Searching a database of 3D-volume objects for objects which are similar to a given 3D search object is an important problem which arises in number of database applications -- for example, in Medicine and CAD. In this paper, we present a new geometry-based solution to the problem of searching for similar 3D-volume objects. The problem is motivated from a real application in the medical domain where volume similarity is used as a basis for surgery decisions. Our solution for an efficient ...

17 [Session 13 \(wednesday, June 7th--4:40-5:40 pm\): Exact computation of protein](#)[structure similarity](#)

L. Paul Chew

June 2006 **Proceedings of the twenty-second annual symposium on Computational geometry SCG '06**

Publisher: ACM Press

Full text available: [pdf\(219.41 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

A protein can be considered as a string (on the alphabet of 20 amino acids) or as a structure (each protein folds into a particular 3D configuration). Consider the following string-based problem: Given two protein strings that are not necessarily similar in their entirety, determine the *most similar* contiguous substrings, one from each protein. The exact meaning of *most similar* here is determined by the user; it is based on user-specified scores for character vs. character similarity ...

Keywords: convex hull, dynamic programming, extreme points, global optimization,

protein geometry, protein structure, proteins, structure comparison

18 [Content-based retrieval of 3D models](#)

Alberto Del Bimbo, Pietro Pala

February 2006 **ACM Transactions on Multimedia Computing, Communications, and Applications (TOMCCAP)**, Volume 2 Issue 1

Publisher: ACM Press

Full text available: [pdf\(995.25 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

In the past few years, there has been an increasing availability of technologies for the acquisition of digital 3D models of real objects and the consequent use of these models in a variety of applications, in medicine, engineering, and cultural heritage. In this framework, content-based retrieval of 3D objects is becoming an important subject of research, and finding adequate descriptors to capture global or local characteristics of the shape has become one of the main investigation goals. In t ...

Keywords: 3D shape description, comparative analysis, retrieval by content of 3D models

19 [Papers: surfaces: A similarity-based approach to perceptual feature validation](#)

Theresa Cooke, Florian Steinke, Christian Wallraven, Heinrich H. Büthoff

August 2005 **Proceedings of the 2nd symposium on Applied perception in graphics and visualization APGV '05**

Publisher: ACM Press

Full text available: [pdf\(589.49 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Which object properties matter most in human perception may well vary according to sensory modality, an important consideration for the design of multimodal interfaces. In this study, we present a similarity-based method for comparing the perceptual importance of object properties across modalities and show how it can also be used to perceptually validate computational measures of object properties. Similarity measures for a set of three-dimensional (3D) objects varying in shape and texture were ...

Keywords: features, haptic, multidimensional scaling, perception, shape, similarity, texture, touch, validation, vision

20 [Similarity querying II: Using sets of feature vectors for similarity search on voxelized](#)[CAD objects](#)

Hans-Peter Kriegel, Stefan Brechelsen, Peer Kröger, Martin Pfeifle, Matthias Schubert

June 2003 **Proceedings of the 2003 ACM SIGMOD International conference on****Management of data**

Publisher: ACM Press

Full text available: [pdf\(838.51 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

In modern application domains such as multimedia, molecular biology and medical imaging, similarity search in database systems is becoming an increasingly important task. Especially for CAD applications, suitable similarity models can help to reduce the cost of developing and producing new parts by maximizing the reuse of existing parts. Most of the existing similarity models are based on feature vectors. In this paper, we shortly review three models which pursue this paradigm. Based on the most ...

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